Manufacturing in Denmark

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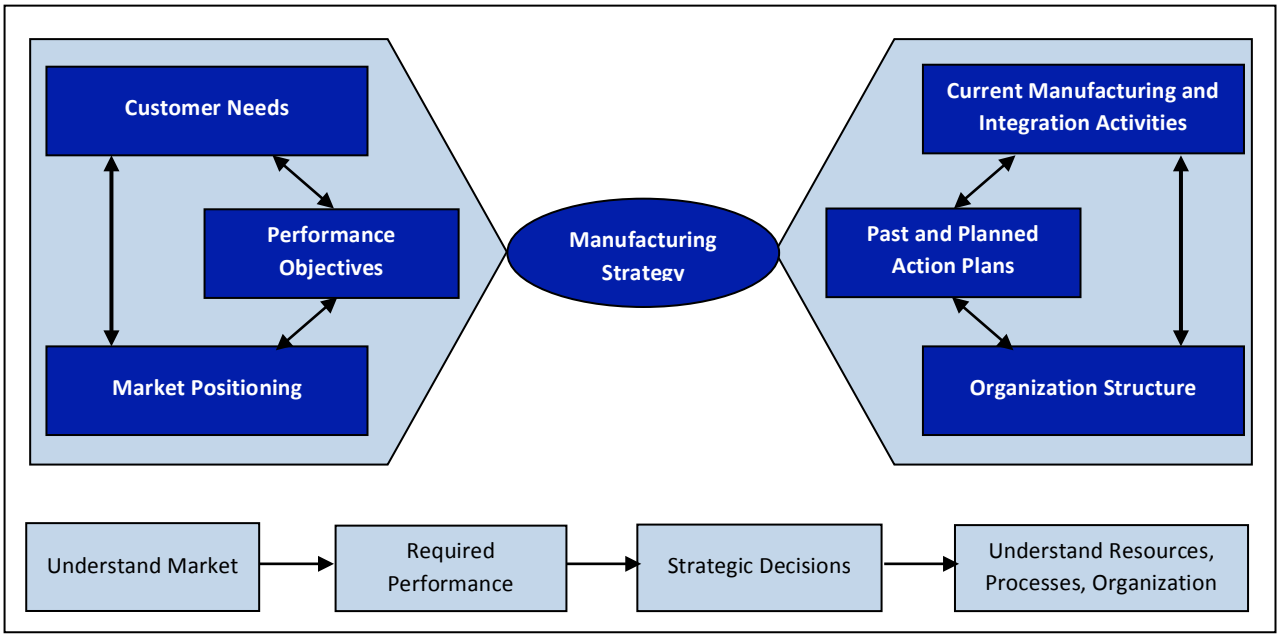

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Foreword

This report compares the manufacturing strategies, practices, performances and improvement activities of 39 companies that are representative for the Danish assembly industry with those of 804 companies from 19 other countries.

The data supporting this report were collected in 2013 and concern:

- Manufacturing strategies pursued and implemented between 2010 and 2012.
- Performance improvements achieved during that period.
- Actual manufacturing practices and performances as well as competitive priorities in 2012.
- Manufacturing strategies pursued for the years 2010-2012.

As this reports is the next in a series of country-reports, pieces of text that are still relevant has been copied from earlier editions, with consent from the authors of these reports.

Aalborg, September 2014

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1 Introduction

Manufacturing strategy involves (Ruffini *et al*., 2000):

- Making and implementing decisions about the design of a company's manufacturing, manufacturing management, and maintenance *processes*, the *technologies* (incorporated in *people* and *resources*) needed to perform these processes, and the *organisational arrangements* (structure and culture) dividing and coordinating the processes [1].
- Ensuring that these decisions align properly (*internal consistency*) and that they are examined in the light of their contribution to the manufacturing tasks, i.e. providing the capacities and capabilities that are needed for the company to qualify for, and to win orders in, the markets they serve (*external consistency*).
- Managing this ought to be an *ongoing process* of: planning and designing, implementing, monitoring, learning, (re-)planning and (re-)designing, etc.

Crucial to the future of any industrial company manufacturing strategy:

1. Appears in what companies are and do, and
2. Determines what they intend(ed) to be and do.

Without a manufacturing strategy, companies run the risk of drifting like snowflakes in the wind with potentially devastating effects in view of the current global manufacturing environment, which is in an ongoing process of change, and has become more and more complex, dynamic, and unpredictable in several industries. Within this dynamic environment, manufacturing strategy requires considerable resources and effort in terms of managerial time, with increasing pressures for innovation, knowledge sharing, and collaboration.

Based on the data collected through the 2013 International Manufacturing Strategy Survey (IMSS) [2], this report compares the manufacturing strategies, practices, performances, and improvement activities of Danish industry with those of companies from 19 other countries. The IMSS has been performed every five years since 1992. This is the length of time within which companies are normally able to assess the effects of strategic change. The survey is performed by a collaborative research network of more than 20 business schools around the world. Each round, the manufacturing strategies, practices, and performance of over 600 companies are surveyed. The 2013 version involved 843 companies.

As a non-profit network, IMSS aims to play a major role in:

- Conceptualizing and identifying those manufacturing management policies and practices that contribute best to the strategic objectives of the companies.
- Creating the possibility of performing comparative analyses of manufacturing strategies in the

[1] Other authors have conceptualized these decision areas (process, technology and organisational arrangements) as four structural and four infrastructural decision categories (Hayes and Wheelwright, 1984, p.31), process choice and infrastructure (Hill, 1985, p.41), or five decision areas in which, according to Skinner (1985, pp.61-62), trade-off decisions must be made.

[2] The data were collected in 2013 and concerned the year 2012 (for characteristics of the business unit/plant, its competitive environment, and strategy and performance, both relative to competitors), and the period 2010-2012 for manufacturing (action programs) and performance improvements

assembly industry at national and international levels, and of studying specific hypotheses in the same context.

- Establishing criteria for the introduction of best practices as well as their level of transferability and adaptability to different environments.
- Enabling participating companies to make their own comparative analyses, using sectorial, national and international benchmarks.
- Enhancing industrial performance in the countries involved, and encouraging communication between participating companies and schools on a national level, with regard to specific manufacturing management aspects that directly affect these companies.

This report starts addressing why manufacturing matters in Denmark. After a brief description of the research method and sample, the commercial profiles of the companies involved are described in terms of their competitive priorities and market positioning. Then, the companies' current manufacturing and integration practices, technologies, organizational structure, and people management policies are analyzed. Subsequently the company performance and improvements therein are addressed. The report is concluded with a summary of the main findings from the survey.

2 Method and Sample Description

Like its predecessors, the IMSS 2013 questionnaire was designed to identify and explore the strategies, practices, performance, and action plans used by manufacturing firms around the world.

Focusing on these issues, this report benchmarks 39 Danish assembly firms against a sample of 804 companies from 19 other countries. Countries from Europe, Asia, and North America are included in the sample. Table 1 summarizes statistics characterizing the 20 sub-samples.

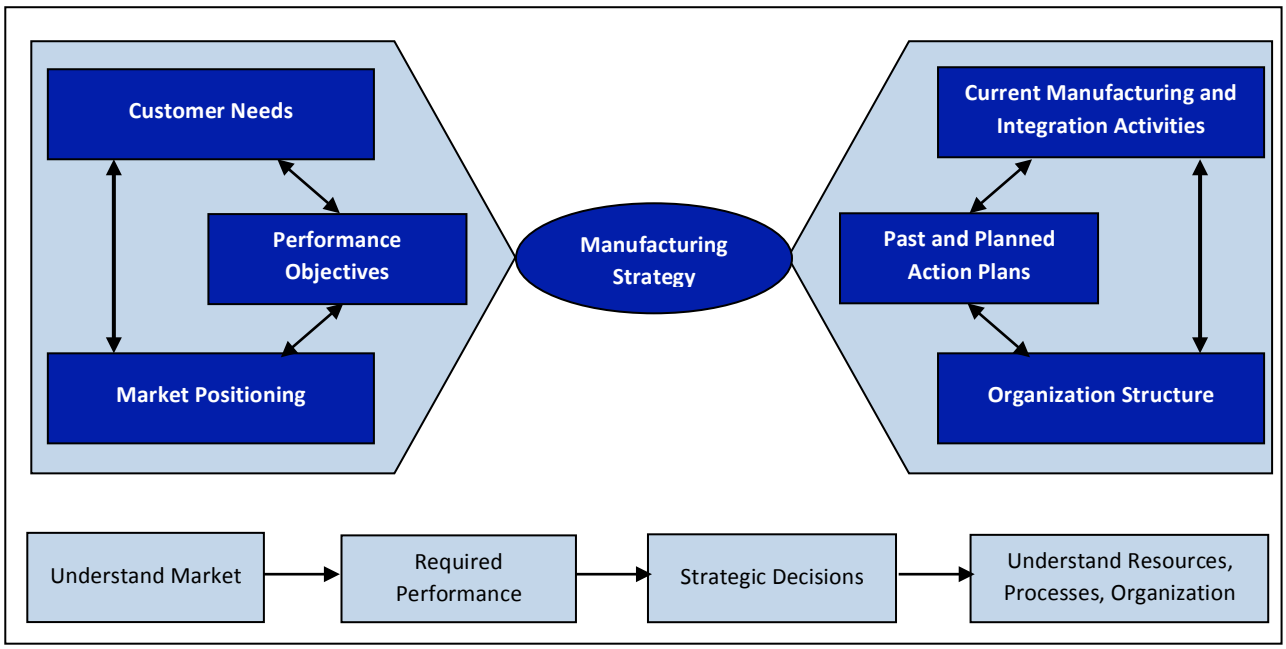

Figure 1 – Schematic disposition of the questionnaire

The sample was drawn from ISIC 25-30 categories – see Table 2 for details.

The 2013 survey instrument consisted of around 170 questions, divided into three sections, as follows:

- Description, strategy, and performance of the business unit.
- Description, strategy, performance, performance improvements, and performance objectives of the dominant activities of the plant.
- Current manufacturing and supply chain practices, and past action programs

Table 1 – The IMSS samples by country

Respondents profiles		
Country	Number of companies	Percentage of sample
Belgium	30	3.6%
Canada	27	3.2%
China	133	15.8%
Denmark	39	4.6%
Finland	34	4.0%
Germany	24	2.8%
Hungary	57	6.8%
India	136	16.1%
Italy	56	6.6%
Malaysia	18	2.1%
Netherlands	49	5.8%
Norway	29	3.4%
Portugal	34	4.0%
Romania	40	4.7%
Slovenia	17	2.0%
Spain	30	3.6%
Sweden	32	3.8%
Switzerland	30	3.6%
Taiwan	28	3.3%
EU[3]	501	59.4%
Non-EU	324	40.6%
Total	843	100%

[3] For reasons of convenience, Norway and Switzerland are included in the EU sample.

Table 2 – The IMSS sample profile: ISIC codes (percentages)

Respondents profiles						
Country	ISIC 25	ISIC 26	ISIC 27	ISIC 28	ISIC 29	ISIC 30
Belgium	23%	7%	7%	30%	30%	3%
Canada	59%	7%	11%	19%	4%	0%
China	20%	21%	14%	24%	16%	6%
Denmark	18%	18%	8%	56%	0%	0%
Finland	29%	3%	15%	44%	9%	0%
Germany	50%	4%	0%	33%	13%	0%
Hungary	39%	4%	23%	23%	11%	2%
India	11%	32%	20%	15%	14%	8%
Italy	33%	6%	13%	39%	4%	6%
Malaysia	35%	18%	24%	12%	6%	6%
Netherlands	45%	10%	8%	27%	4%	6%
Norway	66%	0%	3%	28%	0%	3%
Portugal	50%	9%	9%	21%	9%	3%
Romania	53%	5%	28%	10%	5%	0%
Slovenia	41%	12%	24%	24%	0%	0%
Spain	50%	7%	13%	20%	7%	3%
Sweden	19%	6%	3%	38%	25%	9%
Switzerland	17%	7%	23%	47%	7%	0%
Taiwan	26%	41%	15%	7%	7%	4%
EU	38%	7%	13%	31%	8%	3%
Non-EU	21%	26%	17%	18%	13%	6%
Total	31%	14%	15%	26%	10%	4%

25 - Manufacture of fabricated metal products, except machinery and equipment
26 - Manufacture of computer-, electronic and optical products
27 - Manufacture of electrical equipment
28 - Manufacture of machinery and equipment not elsewhere classified
29 - Manufacture of motor vehicles, trailers, and semi-trailers
30 - Manufacture of other transport equipment

3 Does Manufacturing Matter in Denmark?

Danish industry is highly varied and almost every business sector is represented in the economy. Denmark is well known internationally for its toys, fashion and furniture, beer, pork and bacon, shipping, windmills, roof windows, isolation materials, medical products and appliances, pumps, valves, and electronic products. The majority of Danish industry are small and medium sized enterprises. About 95% of the total number of manufacturing companies have less than 100 employees. Even the largest Danish manufacturing enterprises are small by international standards. The few firms with more than 500 employees represent 17% of all employees in

manufacturing. The western parts of Denmark – notably west and central Jutland, have the highest degrees of industrialization.

Although there is a number of leading knowledge-based companies in Denmark, the industry and its exports are still dominated by relatively high-wage, yet less knowledge-intensive production. The high wage levels seem to be compensated for by relatively higher levels of flexibility, better innovation (at all levels including the shop floor) and collaborative abilities.

Employment in the Danish manufacturing industry has fallen significantly over the past 40 years, from 23% in 1972 to 11% in 2012. In the same period of time, manufacturing's share of gross added value has dropped from 18% to 11%, while production, because of the financial crisis, has fallen 15% since 2005. (Agerskov and Bisgaard, 2013, p. 402)

As in 2005, by far the largest sector is manufacturing of food, beverages and tobacco, followed by manufacturing of machinery and equipment. However some changes has happened, for instance the share of manufacturing of machinery and equipment has risen from 12% in 2000 to 17,5% in 2012.

Since 1999 there has been an increasing surplus on the trade in services, until 2008, when the surplus reached €7 billion. Since then it has fallen a little bit, to a surplus of €5.7 billion.

Enterprises in manufacturing accounted directly for 38% of all sales of goods and services abroad (Agerskov and Bisgaard, 2013, p. 390). Relative to the total turnover of the manufacturing industry, this figure is about 51%. Two major sectors in the IMSS survey, manufacturing of electrical and optical equipment and manufacturing of machinery and equipment even export respectively 86% and 82% of their turnover (Agerskov and Bisgaard, 2013, p. 403).

So, although its contribution to Danish GDP has fallen (partly due to former "manufacturing" activities being outsourced to what has become a flourishing service sector of logistical service providers, IT-companies, and professional caterers), manufacturing does matter indeed, in terms of production, employment, export and, not least, reputation.

4 Competitive Priorities

The respondents were asked to indicate the importance of fifteen different order winners, that is, the performance criteria companies use to try and beat their competitors in the market place. Table 3 shows that the Danish sample scores are close to the European averages. The exceptions are *lower selling prices, more safe and health-respectful processes, and higher contribution to the development and welfare of society* where Denmark scores around 0.5 lower than the EU average. These results could be explained by Denmark's current position as one of the highest-wage

Table 3 – Competitive priorities (1 = not important, 5 = very important) [4]

	Priority														
Country	Lower selling prices	Product design & quality	Conformance quality	Delivery reliability	Faster deliveries	Superior Product assistance / support	Customer service	Offer more product customization	Wider product range	Newer products more frequently	More innovative products	Greater order size flexibility	Environmentally sound products	Higher contribution to the development and welfare of society	More safe and health respectful processes
Belgium	3.6	4.0	4.1	4.3	4.0	3.6	3.5	3.6	3.4	3.0	3.6	3.3	3.3	2.9	3.5
Canada	4.0	3.9	4.2	4.1	3.9	3.9	3.7	4.0	3.4	3.1	3.3	3.4	2.7	2.3	3.4
China	3.6	4.2	4.2	4.1	3.8	4.0	3.7	3.6	3.4	3.4	3.6	3.3	3.3	3.1	3.5
Denmark	3.3	4.3	4.0	3.9	3.7	4.2	3.9	3.9	3.4	3.0	3.7	3.1	2.9	2.3	2.7
Finland	3.4	4.2	4.0	4.0	3.8	3.9	3.4	3.9	3.3	3.1	3.5	3.4	3.1	2.6	3.2
Germany	4.1	4.2	4.3	4.4	4.0	3.7	3.6	3.0	2.9	4.0	n.a.	3.1	3.1	2.6	2.8
Hungary	4.0	4.5	4.5	4.5	4.1	3.5	3.3	3.4	3.3	3.0	3.3	3.7	3.2	2.9	3.5
India	3.8	4.5	4.5	4.4	4.2	4.0	3.8	3.9	4.1	3.8	4.0	3.8	3.9	3.7	3.9
Italy	4.0	4.0	4.1	4.1	4.1	4.0	3.7	3.8	3.2	2.9	3.5	3.0	2.8	2.5	3.1
Malaysia	4.1	4.7	4.5	4.3	3.9	4.2	4.0	3.7	3.8	3.2	3.7	4.0	3.6	3.4	4.1
Netherlands	3.8	4.2	4.2	3.9	3.7	3.9	3.4	3.5	3.1	2.9	3.5	3.2	2.9	2.7	3.1
Norway	3.1	4.1	3.9	4.1	4.0	3.7	3.1	3.5	3.4	3.1	3.4	3.7	3.5	3.3	3.5
Portugal	4.0	4.4	4.5	4.3	4.1	3.8	3.6	3.9	3.7	3.1	3.8	3.7	3.2	2.8	3.1
Romania	3.9	4.1	4.0	3.9	4.0	3.6	3.5	3.4	3.9	3.5	3.5	4.1	3.4	3.4	3.8
Slovenia	3.9	4.2	4.5	4.2	4.0	3.8	3.2	3.6	3.6	3.2	3.7	3.8	3.4	3.3	3.9
Spain	4.3	4.0	4.2	4.0	4.2	3.9	4.0	3.8	3.5	3.1	3.7	3.4	3.0	2.7	2.9
Sweden	3.4	4.1	4.1	3.9	3.6	3.8	3.6	3.6	3.3	3.2	3.7	3.1	3.2	2.8	3.0
Switzerland	3.6	4.4	4.1	4.3	3.7	4.0	3.7	3.9	3.3	3.0	3.7	2.8	2.4	2.3	2.6
Taiwan	3.6	4.3	4.1	3.9	4.1	4.1	4.1	3.6	4.1	3.9	4.0	4.0	3.6	3.6	3.6
EU	3.8	4.2	4.2	4.1	3.9	3.8	3.5	3.6	3.4	3.1	3.6	3.4	3.1	2.8	3.2
Non-EU	3.7	4.3	4.3	4.2	4.0	4.0	3.8	3.8	3.7	3.6	3.8	3.6	3.5	3.3	3.7
Total	3.8	4.2	4.2	4.1	3.9	3.9	3.6	3.7	3.5	3.3	3.7	3.5	3.3	3.0	3.4

[4] Highlighted cells are the top scorers for each category

countries in the world, meaning that Danish companies generally do not compete on price. The other points could be explained by Denmark's already very strict rules regarding work safety and health, and Denmark's welfare system, meaning that Danish companies do not have to focus on these areas.

However, the Danish companies' highest priority is to stay or become leaders in *product design and quality*, but they are not the only ones: with an average score of 4.3, they are only marginally more aggressive than the average EU company. However, they are behind Hungary, Portugal, Switzerland, and perhaps more worryingly, India and Malaysia (as top scorers, scoring 4.5 and 4.7), two emerging countries.

Another key competitive criterion is offering *better conformance quality*. Interestingly, though this is the second most used competitive priority, Denmark is behind or equal to all countries, except Norway (scoring 0.1 lower than Denmark).

Environmentally sound products, and *newer products more frequently* are given less attention than the other priorities. In these cases, Danish companies are also scoring lower than both the EU and the non-EU average.

Overall, it appears that Danish companies are primarily competing on *quality* (product design and quality, conformance quality, delivery reliability) and *customer service* (superior product assistance/support, customer service, offer more product customization), which are the only priorities where Denmark scores more than 0.1 over the EU average.

5 Market Characteristics

Denmark is a small, open economy, in which foreign trade accounts for a significant part of economic activity.

The EU countries are Denmark's main trading partners. In 2012, the ten largest export markets accounted for 63% of total Danish exports (45% of exports went to nine European countries, with Germany and Sweden accounting for approx. 10% each; 14% went to the USA; and interestingly 4% went to China. This number has been almost doubled since 2005). Ten countries accounted for 62% of total imports into Denmark (48% of imports come from eight European countries, including 13% from Germany; 3% and 11% came from China and the USA, respectively). Especially imports from China are increasing steeply, while a rapid decrease is seen in imports from USA.

In many respects, the market and competitive environments of Danish companies are comparable to those of the average company in the sample. The (minor) exception is *rate of technological change* where Danish, Dutch, Canadian and Swiss companies are experiencing less technological change in the market than any other countries. This could be explained by the fact that these countries' companies already are among the most technologically advanced in the world, meaning that Danish companies do not feel the technological stress from the market. At the other end of the scale, emerging economies like India and Taiwan dominate.

It is interesting that India reports having the *market most open to new players*, while the Hungary, Germany and China together with Denmark report a *market relatively closed to new players*. This

can be worrying in a time where the future of Danish industry is very dependent on start-ups, and where the Danish government as well as EU is doing programs supporting start-up ventures.

Table 4 – Market characteristics [5]

Market characteristics											
Country	Market Size (Declining rapidly - Growing rapidly)	Rate of technological change (Low - High)	Market span (Few segments - Many segments)	Market concentration (Few competitors - Many competitors)	Competitive rivalry within industry (Very low - Very high)	Market entry (Closed to new players - Open to new players)	Threat that your products will become substituted (Very low - Very high)	Bargaining power of suppliers (Very weak - Very strong)	Bargaining power of customers (Very weak - Very strong)	Environmental pressure (Very weak - Very strong)	Social pressure (Very weak - Very strong)
Belgium	3.0	3.2	2.9	3.1	3.5	2.8	2.7	3.0	3.8	3.3	3.4
Canada	3.1	2.8	3.6	3.3	3.8	3.0	2.9	3.3	3.6	2.9	3.4
China	3.5	3.4	3.4	3.7	4.0	2.7	2.9	3.1	3.6	3.4	3.2
Denmark	3.4	2.9	3.4	3.1	3.6	2.8	2.9	2.8	3.5	3.1	3.1
Finland	3.1	2.9	3.5	3.2	3.7	3.0	2.8	3.1	3.5	3.4	2.8
Germany	3.1	3.3	3.3	2.9	4.0	2.7	3.0	2.6	3.9	3.0	3.1
Hungary	3.3	3.6	3.6	3.6	4.0	2.6	2.8	3.1	4.1	3.2	3.3
India	4.0	3.8	3.9	3.9	3.8	3.5	2.9	3.3	3.5	3.6	3.6
Italy	3.0	3.2	3.1	3.1	3.9	2.8	2.6	2.9	4.1	3.2	3.1
Malaysia	3.7	3.2	3.6	4.1	4.2	3.4	3.2	3.3	3.8	3.8	3.7
Netherlands	3.1	2.9	3.3	3.2	3.7	2.8	2.7	3.0	3.7	3.0	2.9
Norway	3.8	3.4	3.4	3.3	3.4	3.0	3.0	2.7	3.2	3.1	3.6
Portugal	3.0	3.2	3.5	3.9	4.4	2.8	3.4	3.2	4.1	3.6	3.4
Romania	3.0	3.3	3.2	3.5	3.8	3.4	3.2	3.5	3.7	3.4	3.1
Slovenia	3.2	3.3	3.5	3.6	4.1	2.8	2.9	3.5	3.7	3.7	3.5
Spain	2.8	3.0	3.5	3.2	3.9	3.0	3.2	3.2	3.8	3.4	3.1
Sweden	3.5	3.4	3.3	3.0	3.9	3.1	3.1	3.1	3.9	3.2	3.3
Switzerland	3.2	2.9	3.4	3.3	3.8	3.1	2.9	2.8	3.7	3.2	3.0
Taiwan	3.5	3.8	3.7	3.9	4.0	3.2	3.4	3.6	3.7	3.4	2.9
EU	3.2	3.2	3.3	3.3	3.8	2.9	2.9	3.0	3.8	3.2	3.2
Non-EU	3.6	3.6	3.6	3.8	3.9	3.1	3.0	3.2	3.6	3.4	3.4
Total	3.4	3.3	3.5	3.5	3.9	3.0	2.9	3.1	3.7	3.3	3.2

Not surprisingly, Indian companies report that they are active in many and rapidly growing markets. Here Denmark is also reporting minor increased activity compared to the rest of EU. Both Denmark and India's manufacturing industry is primarily serving a market outside its own

[5] Green highlights are top scorers, red cells bottom performers in each column.

country's borders.

6 Risk Evaluation & Management

Having examined the challenges of the market the businesses are operating in, it is interesting to look at the risks and management of risks in the respective countries.

6.1 Risk Evaluation

The following section is partly based on the risk probability and risk impact matrix, which is used to evaluate risks. Just like the questionnaire, the matrix uses two 5-point Likert scales to rate and evaluate how risky an operation is.

		Impact				
		Trivial	Minor	Moderate	Major	Extreme
Probability	Rare	Low	Low	Low	Medium	Medium
	Unlikely	Low	Low	Medium	Medium	Medium
	Moderate	Low	Medium	Medium	Medium	High
	Likely	Medium	Medium	Medium	High	High
	Very likely	Medium	Medium	High	High	High

Figure 2 – Risk probability and impact matrix

As it can be seen in Table 5, Danish companies are generally in the same risk-situation as the rest of the EU. With only minor differences in for instance impact of *manufacturing operations are interrupted, affecting your shipments,* and *your shipments operations are interrupted affecting your deliveries* where Danish companies asses this impact 0.2 lower than other European companies, the Danish companies are very average.

In comparison to the EU, Denmark has a marginally larger degree of *customer deliveries affected by operational failures*. This degree of 5% is, however, high compared to Canadian companies for instance who are experiencing about the same risks as Danish companies, but only have 1.7% *deliveries affected by operational failures*.

Countries like China and Malaysia who, according to Table 14, are having a higher degree of mass production, also tends to have a higher degree of *% of customers deliveries affected by operational failures.* This could be explained by the minimization of slack and flexibility often seen in mass-producing companies. The exception is India, who, apart from having the largest degree of mass production, also has the lowest non-EU degree of *customer deliveries affected by operational failures*, apart from Canada.

Table 5 - Risk evaluation

Risk evaluation								
	Key supplier fails to supply, affecting operations		Manufacturing operations are interrupted, affecting your shipments		Your shipment operations are interrupted affecting your deliveries		Days with lost production[6]	Percentage of customer deliveries affected by operational failures
Country	Probability	Impact	Probability	Impact	Probability	Impact		
Belgium	2.4	3.7	2.4	3.5	1.5	3.1	5	4.00
Canada	2.5	3.4	2.0	3.7	1.9	3.4	3	1.70
China	2.7	3.3	2.5	3.1	2.2	2.8	17	10.36
Denmark	2.6	3.7	2.3	3.4	2.0	3.2	6	4.97
Finland	2.9	3.8	2.3	3.6	2.1	3.2	16	7.94
Germany	2.9	2.9	2.7	4.0	2.8	3.8	6	3.25
Hungary	2.9	3.8	2.9	3.6	2.6	3.6	9	3.48
India	3.1	3.7	2.9	3.6	3.0	3.7	8	3.20
Italy	2.2	3.9	1.9	3.4	1.7	3.5	10	4.98
Malaysia	2.6	3.1	3.1	3.5	3.0	3.5	7	12.38
Netherlands	2.5	3.7	2.2	3.3	1.8	3.0	8	3.56
Norway	2.8	3.7	2.9	3.3	2.2	3.4	6	2.71
Portugal	2.6	4.1	2.0	3.9	1.6	3.7	8	3.58
Romania	2.4	3.4	2.1	3.2	2.1	3.0	7	4.08
Slovenia	2.6	4.2	2.7	4.0	2.5	3.5	5	1.92
Spain	2.8	3.9	2.3	3.7	2.2	3.7	-	4.48
Sweden	2.7	3.8	2.5	3.8	2.2	3.5	9	2.44
Switzerland	2.8	3.7	2.1	3.8	2.2	3.5	11	6.48
Taiwan	3.6	4.0	3.6	4.0	3.9	4.0	10	3.40
EU	2.6	3.8	2.4	3.6	2.1	3.4	-	4.22
Non-EU	2.9	3.5	2.8	3.5	2.7	3.3	11	6.80
Total	2.7	3.7	2.5	3.5	2.3	3.4	-	5.13

6.2 Risk Management

Table 6 was constructed to give a view on how companies manage these risks. Operational risk management is an area getting increased attention as companies are geared harder. The benefits from operational risk management are multiple, including reduction of operational loss, lowering of compliance cost, early detection of unlawful activities, and reduced exposure to future risks.

One would expect the Danish level of risk management implementation effort in the last three years to be about average, meaning that Danish companies would put about the same effort into managing risks as the level of risks probability and impact together. However in this area, Danish companies are way behind companies in all other countries. In fact, Danish companies are the worst in the world when it comes to this implementation effort in the last three years in all of the analyzed areas: *prevention of, detection of, response to* and *recovering from risks.* This counter-intuitive result could be based on many factors, including that Danish companies may feel they

[6] Due to supply or operations failures

already have so good measures to cope with risks that they have not taken extra effort to implement risk management in the last three years.

As expected, companies in countries like Taiwan, who are operating in a more risky environment, also tend to put more effort in managing these risks.

Table 6 – Effort put into implementing risk management programs in the last three years
(1 = no effort, 5 = high effort)

Risk management				
Country	Preventing risks	Detecting risks	Responding to risks	Recovering from risks
Belgium	3.4	3.2	3.1	3.1
Canada	3.0	3.1	3.0	2.7
China	3.2	3.1	3.2	3.0
Denmark	2.9	2.7	2.8	2.5
Finland	3.7	3.1	3.2	3.0
Germany	3.2	3.2	3.2	3.6
Hungary	3.5	3.4	3.3	3.1
India	3.7	3.5	3.7	3.5
Italy	3.6	3.3	3.1	3.0
Malaysia	3.5	3.5	3.3	3.3
Netherlands	3.2	3.0	3.1	2.8
Norway	3.4	3.3	3.6	3.0
Portugal	3.3	3.5	3.3	3.1
Romania	3.2	3.2	3.4	3.2
Slovenia	3.7	3.8	3.6	3.7
Spain	3.8	3.2	3.1	3.3
Sweden	3.4	3.1	3.0	3.2
Switzerland	3.1	3.1	3.0	3.3
Taiwan	3.7	3.6	3.7	3.8
EU	3.4	3.2	3.2	3.1
Non-EU	3.5	3.3	3.4	3.3
Total	3.4	3.3	3.3	3.1

7 Operations Management

Operations management is an area of management concerned with overseeing, designing, and controlling the process of production and redesigning business operations in the production of goods or services.

7.1 Production Processes, Technology and Quality Management

Strategy implementation is the process by which strategies and policies are put into action through the development of programs, budgets, and procedures (Wheelen and Hunger 1980). This process may involve changes within the overall culture, structure, technologies and/or management system of the organization.

To address this part of the manufacturing strategy, the respondents were asked to indicate and assess the level of effort of implementing their companies' action programs [7] in the past three years. The respondents were asked to indicate, for 56 different action programs:

- The effort put into implementation within the last three years.
- The current of implementation.

The following will evaluate the effort put into implementation in the last three years.

When looking at the following action programs, a clear picture emerges, a picture of Danish companies lagging behind in almost all areas when compared to the rest of the EU companies.

This is the case for all action programs except *quality improving,* where Denmark is right on the European average of 3.2. Worst are the cases of *tracking and tracing, advanced processes,* and *equipment availability,* where the level of implementation in Danish companies falls 0.6 points behind the European average. Generally Denmark is the country with the second lowest effort put into implementing action programs over the last three years. The sum of the effort degree is 28.6 for Denmark, only surpassed by Canada whose sum is just 0.3 points lower.

When comparing to the rest of the world, the picture is even darker. Indian companies are leading the implementation effort in almost all areas, followed by Taiwan. Companies in these countries are very focused on implementing the action programs.

One possible explanation of this could be that Danish companies are very developed, and have focused on these programs for many years; meaning that they are as much implemented in the companies as the companies wants them to be, while looking at action programs is newer to the less developed production companies, operating in for instance India and Taiwan. This would also explain why the West and North European companies are all lower than the Eastern European companies.

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[7] An action program is a major project aimed at producing considerable changes in the company's management practices and organization, to which a company is devoting high resources and innovation efforts, and on which management focus and commitment is concentrated.

Table 7 – Effort put into implementing production process, technology and quality management programs in the last three years (1 = no effort, 5 = high effort)

Action programs pursued the last three years											
Country	Process focus	Pull production	Forecasting and planning accuracy	Information integration	Tracking and tracing	Advanced processes	The factory of the future	Automation programs	Quality improving	Equipment availability	Benchmarking
Belgium	3.6	3.1	2.9	3.1	2.7	2.8	2.4	3.1	2.9	2.7	2.3
Canada	2.9	2.9	2.9	2.8	2.3	2.1	2.0	2.0	3.0	2.8	2.5
China	3.1	3.1	3.1	3.0	2.8	2.6	2.5	2.8	3.2	3.3	3.4
Denmark	3.3	3.1	3.0	2.7	2.2	2.1	2.1	2.5	3.2	2.3	2.0
Finland	3.7	2.9	3.0	3.0	2.6	2.4	2.5	2.6	2.9	2.5	2.3
Germany	3.5	2.9	2.7	2.6	2.4	2.9	2.2	2.9	3.1	3.1	2.7
Hungary	3.2	3.1	3.1	3.3	3.0	3.0	2.5	2.7	3.3	3.3	2.8
India	3.5	3.4	3.7	3.6	3.7	3.7	3.5	3.7	3.8	3.7	3.8
Italy	3.8	3.4	3.5	3.4	2.8	2.7	2.0	2.6	3.1	2.6	2.4
Malaysia	3.1	3.2	3.2	3.1	2.9	2.9	2.7	2.6	3.1	2.8	2.7
Netherlands	3.5	3.1	3.2	3.1	2.5	2.5	2.1	2.6	2.9	2.7	2.2
Norway	3.2	3.2	3.3	3.2	3.4	3.2	2.9	3.0	3.6	3.1	2.7
Portugal	4.2	3.7	3.5	3.4	3.1	3.1	2.5	3.1	3.3	3.1	2.5
Romania	3.2	3.0	3.4	3.4	3.1	2.6	2.5	2.7	3.6	3.4	2.9
Slovenia	3.6	3.3	3.6	3.2	3.5	3.3	2.8	3.2	3.1	3.2	3.1
Spain	3.7	3.6	3.5	3.4	2.7	2.4	2.4	2.8	3.5	3.3	2.8
Sweden	3.5	3.4	3.2	3.1	2.7	2.6	2.7	2.8	3.4	3.2	2.8
Switzerland	3.2	2.9	3.2	2.6	2.4	2.7	2.7	2.7	2.7	2.8	2.2
Taiwan	3.2	3.5	3.4	3.6	3.5	3.5	3.3	3.3	3.8	3.9	3.8
EU	3.5	3.2	3.2	3.1	2.8	2.7	2.4	2.8	3.2	2.9	2.5
Non-EU	3.3	3.2	3.4	3.3	3.2	3.1	2.9	3.1	3.5	3.5	3.5
Total	3.4	3.2	3.3	3.2	2.9	2.9	2.6	2.9	3.3	3.1	2.9

7.2 Services and Servitization

The term servitization was introduced by Vandermerwe and Rada in 1988 (Vandermerwe & Rada, 1988), and is covering the practice of offering different service and support packages alongside the main product. According to the Danish Institute of Technology, servitization might be especially important for smaller innovative manufacturing companies. Thus it is important that Danish companies at least consider embarking on this trend.

When Table 8 is considered, it does look like Danish companies find service offering very important, indeed. Danish companies offer *maintenance, installation, product upgrades, customer support* and *training* in a higher degree than other European countries, and *offer rental services* and *consultancy* in the same rate as other European companies. Only when it comes to *offering of spare parts* is Denmark marginally behind with 3.3 compared to an EU average of 3.4.

Table 8 – Services offered, service return and effort put into implementing servitization programs in the last three years (1 = none, 5 = high)

Service and servitization														
	To what extend are these offered alongside the products (1 = none, 5 = high)								Percentage of sales based on sales of:			Effort put into implementing these action programs (1 = none, 5 = high)		
Country	Maintenance and repair	Installation services	Rental/lease of products	Product upgrades	Customer support center	Training	Consultancy services	Spare-parts/consumables provision	Parts	Assembles	Services	Expanding the service offering	Developing the skills needed to improve service offering	Designing products for after sales
Belgium	2.6	2.3	1.4	1.9	2.6	2.4	1.9	3.1	32.2	69.4	3.6	2.4	2.6	2.6
Canada	2.5	2.4	1.4	1.8	2.9	2.5	2.6	3.0	25.9	66.7	7.5	2.7	3.0	2.9
China	3.3	3.1	2.1	2.7	3.2	3.1	2.8	3.4	16.3	73.3	7.9	3.2	3.1	3.1
Denmark	3.5	3.0	1.6	2.7	3.2	3.1	2.7	3.3	22.9	70.5	8.9	2.7	2.9	2.7
Finland	3.3	2.9	1.7	2.7	2.4	2.6	2.5	3.7	34.0	54.9	11.1	2.9	2.8	2.8
Germany	2.2	2.0	1.2	1.7	1.9	2.2	2.4	2.6	50.3	40.6	9.2	2.2	2.3	2.7
Hungary	3.3	2.4	1.3	2.2	2.5	2.3	2.8	3.6	35.3	59.1	5.7	2.6	2.7	2.5
India	3.7	3.5	2.9	3.4	3.5	3.4	3.4	3.7	38.6	56.7	20.8	3.6	3.6	3.6
Italy	3.8	3.2	1.6	2.8	3.3	3.3	2.5	4.0	25.5	76.5	6.3	2.9	3.2	3.0
Malaysia	3.5	3.6	2.6	3.3	3.6	3.6	3.4	3.6	37.2	50.3	12.5	3.1	3.1	3.0
Netherlands	2.9	2.7	1.6	2.4	2.8	2.9	2.3	3.3	22.3	68.7	9.0	2.8	2.6	2.9
Norway	2.8	2.6	2.4	2.6	2.4	2.6	2.9	3.0	25.6	51.0	23.4	3.0	3.4	3.0
Portugal	3.2	2.6	1.4	2.4	2.5	2.9	2.6	3.4	27.8	63.0	9.3	2.8	3.2	3.0
Romania	3.2	3.0	2.1	2.7	2.6	2.8	3.0	3.2	38.9	50.4	16.6	3.2	3.2	2.9
Slovenia	2.8	2.5	1.5	1.9	2.6	2.6	3.1	3.5	44.6	49.5	5.8	2.6	2.8	2.8
Spain	3.2	2.9	1.2	2.3	3.3	2.8	3.1	3.6	36.8	52.6	12.5	3.3	3.2	3.0
Sweden	3.0	2.5	1.8	2.5	3.1	2.5	2.5	3.4	34.1	57.9	7.8	2.9	2.7	2.5
Switzerland	3.1	3.3	2.0	3.0	3.1	3.5	3.3	3.9	34.0	57.1	15.9	2.6	2.8	2.6
Taiwan	3.8	3.6	2.4	3.3	3.6	3.2	3.5	3.4	59.5	35.6	7.6	3.5	3.7	3.7
EU	3.1	2.7	1.6	2.5	2.8	2.8	2.7	3.4	31.9	60.4	10.0	2.8	2.9	2.8
Non-EU	3.4	3.3	2.4	3.0	3.3	3.2	3.1	3.5	30.5	62.0	12.9	3.3	3.3	3.3
Total	3.3	2.9	2.0	2.7	3.0	2.9	2.9	3.5	31.3	61.1	11.2	3.0	3.1	3.0

When it comes to *installation* and *rental/lease* of products, the EU countries are well behind the non-EU countries, and especially India is offering these alongside their products to a very high degree. India is also a country where services contribute a lot to the revenue, with as much as 20.8*% of sales based on services*. This is only topped by Norway, where 23.4*% of sales are based on services.* In this area, Denmark is close to the European average, with a contribution margin of 8.9*% of sales based on services.*

Looking at the development of service offering, the *effort put into implementing service action programs,* it is striking how Indian and Taiwanese companies have put a lot of effort into the

development. Here, Danish companies are lagging behind the European average, though only very little. However, the EU and the non-EU averages are very different, with the non-EU countries reporting about 0.5 points more effort spend into the development in the last three years.

7.3 Environmental and Social Sustainability Management

Denmark is known internationally as the "State of Green", and environmental programs have always been important to Danish companies and legislators. Green policies have in some years given some Danish companies an advantage compared to companies from other countries. But if Danish companies want to keep being the most sustainable companies, we should see at least some effort put into pursuing environmental programs. This is also the case. Danish companies are very close to the middle of the scale, with an average effort of 2.4 for all of the environmental and CSR-programs. However, Danish companies must feel they are still leading enough for them to invest much less than their counterparts in the rest of Europe and the world. Compared with these numbers, Danish companies have spent less effort on the implementation of every single program analyzed by this questionnaire. The only countries spending less effort into the implementation of these programs are Canada and The Netherlands, two countries that are generally also regarded green. When considering all programs involving CSR and sustainability, the countries outside of Europe, especially India and Taiwan, are much in front of all other countries.

There are many explanations for why the table is so biased towards the less developed countries. One of them could be that for instance Danish companies have been leading the effort for many years, while companies in for instance India have always been regarded more lenient in the press, regarding environmental and CSR issues (see for instance the Bhopal disaster). Therefore, companies in the less developed countries might have to fight more to get up to western standards.

Table 9 - Effort put into implementing environmental and CSR programs in the last three years (1 = none, 5 = high)

Environmental and CSR programs pursued the last three years										
Country	Environmental certification	Social certifications	Sustainability communication	Consumption reduction	Waste recycling	Occupational health and safety system	Work/life balance policies	Supplier sustainability assessment	Training for suppliers' personnel	Joint effort with supplier for sustainability
Belgium	2.8	1.9	2.2	2.8	2.6	3.0	2.3	2.8	1.7	2.2
Canada	2.2	1.9	2.0	2.2	2.3	3.0	1.6	1.7	1.5	1.4
China	3.5	2.9	3.1	3.1	3.1	3.2	2.9	3.0	2.8	2.9
Denmark	2.7	2.1	2.2	2.8	2.8	2.9	2.1	2.4	1.7	1.9
Finland	2.7	2.2	2.5	2.2	2.5	3.1	2.3	2.5	1.8	2.1
Germany	3.4	3.1	2.6	3.0	2.9	3.5	2.1	2.4	1.9	2.1
Hungary	3.2	2.0	2.8	3.2	3.2	3.0	2.6	3.0	1.8	2.6
India	3.8	3.6	3.8	3.6	3.6	3.8	3.6	3.6	3.5	3.5
Italy	3.0	2.6	2.9	3.1	3.3	4.0	2.4	3.0	2.0	2.0
Malaysia	3.2	2.8	3.1	3.1	2.9	3.4	2.6	3.1	2.9	3.3
Netherlands	2.7	1.8	2.3	2.4	2.5	2.8	2.2	2.7	1.8	2.1
Norway	3.7	3.2	3.4	2.9	3.1	3.5	3.6	3.0	3.0	2.7
Portugal	3.2	2.5	2.9	3.4	3.7	3.7	2.7	3.2	2.1	2.5
Romania	3.2	3.0	2.9	3.1	3.3	3.4	2.7	3.2	2.6	3.0
Slovenia	3.1	2.8	3.2	3.4	3.3	3.8	3.2	3.4	3.1	3.2
Spain	3.2	2.2	2.3	3.0	3.2	3.9	2.8	2.6	1.8	2.1
Sweden	3.3	2.4	2.3	3.2	3.1	3.4	2.8	2.9	2.4	2.3
Switzerland	3.1	2.8	2.5	2.8	2.5	3.1	1.9	2.5	1.7	2.0
Taiwan	3.9	3.5	3.7	3.8	3.8	3.8	3.6	3.9	3.8	3.9
EU	3.1	2.4	2.6	2.9	3.0	3.3	2.5	2.8	2.0	2.3
Non-EU	3.5	3.2	3.4	3.3	3.3	3.5	3.1	3.2	3.1	3.1
Total	3.2	2.7	2.9	3.1	3.1	3.4	2.8	3.0	2.5	2.7

8 Supply Chain Management

Supply chain management (SCM) is the management of the flow of goods and information in the supply chain. SCM can be seen as a control system for leveraging logistics worldwide and for better synchronizing supply and demand.

In the field of supply chain management, it is obvious that Danish companies are not putting a very high effort into action programs. In all fields except *joint decision making* Danish companies have put less effort into them than the average for the EU, and much less effort than the worldwide average. In fact, Danish companies have put the least effort into pursuing SCM-related action programs altogether the last three years. At the opposite end of the scale, Taiwan has put

the most effort into all programs, thus also coming first in the total degree of effort used. Indian and Slovenian companies follow Taiwan closely, whereas Swiss and Dutch companies follow Denmark at the bottom of the scale.

Table 10 – Effort put into implementing supply chain management programs
(1 = none, 5 = high)

Effort in implementation of SCM programs										
	Upstream					Downstream				
Country	Sharing info with key suppliers	Collaborative approach with suppliers	Joint decisions with suppliers	System coupling with suppliers	International sourcing strategy	Sharing info with key customers	Collaborative approach with customers	Joint decision with customers	System coupling with customers	International distribution strategy
Belgium	2.9	2.7	2.8	2.8	2.7	3.0	2.8	3.1	2.5	2.6
Canada	2.9	3.1	3.1	2.7	2.8	2.7	2.7	2.2	2.5	2.3
China	2.9	3.0	2.9	2.7	2.4	2.9	2.7	2.7	2.9	2.5
Denmark	2.7	2.7	2.9	2.4	2.3	2.3	2.4	2.1	2.6	2.6
Finland	3.2	3.3	2.9	2.7	2.7	2.9	3.0	2.5	3.3	2.6
Germany	2.6	2.6	2.4	2.7	3.0	2.5	2.3	2.6	2.9	2.9
Hungary	3.2	3.2	2.8	2.5	2.7	3.3	3.3	2.8	3.2	2.3
India	3.6	3.5	3.4	3.3	3.3	3.4	3.5	3.3	3.4	3.1
Italy	3.4	3.5	3.2	3.0	3.4	3.0	3.2	2.5	2.7	3.5
Malaysia	3.3	3.2	3.4	3.1	3.1	3.1	2.9	2.9	3.1	2.7
Netherlands	3.0	2.9	2.7	2.3	2.4	2.6	2.7	2.2	2.7	2.5
Norway	3.0	3.5	3.1	3.1	2.7	3.2	3.4	3.6	3.4	3.3
Portugal	3.3	3.2	3.0	2.4	3.3	3.4	3.0	2.6	3.4	3.1
Romania	3.2	3.3	3.1	2.8	2.6	3.2	3.4	2.9	3.1	2.6
Slovenia	3.5	3.6	3.5	2.9	2.6	3.7	3.6	3.2	3.6	3.2
Spain	3.2	3.0	3.0	2.6	3.1	3.1	2.8	2.8	3.1	2.9
Sweden	3.3	3.2	2.9	2.6	3.2	2.9	2.7	2.5	3.0	3.0
Switzerland	3.4	3.0	2.7	2.3	3.1	2.4	2.1	1.7	2.2	3.0
Taiwan	3.8	4.0	3.8	3.8	3.8	3.9	3.8	3.7	3.9	3.8
EU	3.1	3.1	2.9	2.6	2.8	3.0	2.9	2.6	3.0	2.8
Non-EU	3.3	3.3	3.2	3.0	3.0	3.2	3.1	3.0	3.2	2.9
Total	3.2	3.2	3.1	2.8	2.9	3.0	3.0	2.8	3.1	2.8

9 Performance Improvements Achieved

The performance of companies can be measured along a variety of dimensions. This section focuses on financial and market performance, as well as the longer-term development (investment in R&D, technology and people) and short-term operational performance underlying these shareholder values.

9.1 Sales and Profits

The last seven years have been rough on production companies. Many companies have gone bankrupt during the crisis and even more have had to lay off people. However, some economists think that the crisis is over now. This is also what we see in the sales and profit figures. Worldwide, companies have reported that they are experiencing a positive development in sales, compared to three years ago. This number is largest, however, for non-EU companies.

The IMSS questionnaire measured the development of *sales revenue* in the last three years using a five-point scale with 1 = much worse, 3 = no difference and 5 = much higher. In most countries, sales revenue has increased in the last three years. The exceptions are Canada, which is doing worst with a score of 2.7 (or 0.3 below 3 = same as three years ago), and Norway, Romania, and Spain, which are all at 2.9. Danish companies report an average of 3.1, a slight increase compared to three years ago. Reporting 3.6 on average, Belgian companies are doing best.

The ability to earn money is generally at the same level as three years ago. Worldwide, the average *return on sale* is the same as three years ago at a level of approx. 7.5% (a response of 3 on the 5-point Likert scale correspondents to a ROS of 5-10%). In this field, the European companies are a bit behind the rest of the world, and Denmark is, with an average answer of 2.9, situated between the European average (2.8) and the worldwide average (3.0). The story is about the same for *return on sales compared to three years ago*, where Danish companies are also doing a little bit better than they were three years ago (3.1 or 0.1 above 3 = same as three years ago), while non-EU countries are generally doing even better. India reports the highest compared degree of ROS, at a level of 3.5.

Table 11 – Sales (compared to three years ago: 1 = much lower, 5 = much higher), Return on Sales (1 = <0%, 5 = >20%) and Return on Sales (compared to three years ago: 1 = much lower, 5 = much higher)

Financial Performance			
Country	Sales (3 = same as three years ago)	Return on Sales (1 = < 0%, 3 = 5-10%, 5 = >20%)	Return on Sales (3 = same as three years ago)
Belgium	3.6	3.2	2.9
Canada	2.7	3.4	3.1
China	3.5	3.1	2.9
Denmark	3.1	2.9	3.1
Finland	3.3	2.8	3.0
Germany	3.1	2.9	2.8
Hungary	3.5	2.6	2.9
India	3.5	3.3	3.5
Italy	3.2	2.7	2.8
Malaysia	3.0	3.5	2.7
Netherlands	3.1	3.2	2.9
Norway	2.9	3.3	3.2
Portugal	3.2	2.9	2.9
Romania	2.9	2.5	2.8
Slovenia	3.0	2.3	2.8
Spain	2.9	2.8	2.7
Sweden	3.2	2.9	3.0
Switzerland	3.2	3.0	2.7
Taiwan	3.2	2.8	3.1
EU	3.2	2.8	2.9
Non-EU	3.4	3.2	3.2
Total	3.3	3.0	3.0

9.2 Investment in R&D, Technology, People and Strategic Initiatives

Expenditure on Research and Development (R&D) is one measure of the extent to which businesses develop and exploit new products, process technology, knowledge, and ideas.

Expenditure on R&D by industry and country generates important benefits for Danish companies. In 2012, Denmark spent 2.99% (est.) of GDP on R&D, which, however, was far from the leading countries' performance (Finland – 3.55%, Sweden – 3.41% (est), and, outside the EU, Japan – 3.25% (2011 figure)) [8].

With 2,31% of their sales spent on *R&D*, the Danish companies involved in the IMSS survey put less effort in R&D than their national and international counterparts. This value has fallen significantly since earlier IMSS projects. In 2001 the Danish IMSS companies spent 7.3% on R&D, in 2005 that level had fallen to 5.5%, which was still above the EU but below the non-EU averages. In 2013, the

[8] EUROSTAT - http://epp.eurostat.ec.europa.eu/

Danish IMSS companies reported that they spent 2.31% of annual sales on R&D, which is now below both the EU and the non-EU average. The financial crisis may have had some influence on these values, since companies tend to get leaner and focus on core competencies during time of crisis. However, at the other end of the scale, countries are found with which Danish industry usually compares itself. Among the top countries when it comes to investments in R&D are Sweden, Germany and Switzerland.

Table 12 – Investments in R&D, technology, people and strategic initiatives (% of sales)

	Percentage of sales invested in:				
Country	Product/service related research and development	Investment/improvement of process equipment	Workforce/staff training and education	Strategic initiatives (sustainability, globalization, servitization, etc.)	Total investments
Belgium	2.74	3.63	3.20	2.92	12.49
Canada	2.04	2.74	3.44	3.07	11.30
China	2.62	3.50	3.10	2.92	12.14
Denmark	2.31	3.06	2.89	3.09	11.33
Finland	2.32	3.29	2.81	2.97	11.40
Germany	3.32	3.11	2.90	2.75	12.08
Hungary	1.93	3.51	2.55	2.91	10.90
India	2.59	3.50	3.35	3.50	12.94
Italy	2.78	3.22	2.70	2.83	11.53
Malaysia	2.76	3.00	3.53	2.71	12.01
Netherlands	2.33	3.10	3.24	2.91	11.59
Norway	2.89	2.89	3.33	3.19	12.31
Portugal	2.35	3.24	2.94	2.94	11.46
Romania	1.33	2.88	2.45	2.82	9.47
Slovenia	1.94	3.00	2.29	2.82	10.06
Spain	2.46	2.86	2.76	2.65	10.74
Sweden	3.87	3.18	2.87	3.00	12.92
Switzerland	3.41	3.21	2.96	2.71	12.29
Taiwan	2.17	3.15	2.78	3.08	11.19
EU	2.50	3.18	2.84	2.90	11.42
Non-EU	2.53	3.38	3.23	3.17	12.31
Total	2.51	3.26	3.00	3.01	11.77

Investment in *new process equipment* by Danish companies is relatively low, too, falling, from 9.2% in 2001, through 4.1% in 2005 to 3.1% in 2013, and lower than both the EU (3.2%) and non-EU averages (3.4%). This trend concurs with the falling effort Danish companies put into process

automation and equipment availability (see table 7). In this field, Belgium, surprising to some, is in the lead, followed by some of the countries with larger economic development: China, India, and Hungary.

A well-educated and well-trained workforce is important for the productivity of any company. Compared to their colleagues in many other EU countries, the Danish IMSS companies put just above average efforts into developing a well skilled workforce, both financially and in terms of effort as well (see Section 6.4, Table 7). Notable exceptions to the EU average are the newer member states of the EU, Slovenia, Romania and Hungary. Non-EU countries invest much more in *training and education* than the EU countries. Malaysia is leading the pack, perhaps surprisingly, followed by Canada. In addition, China and India have relatively high investments, and put significantly more effort into their workforce than Denmark and most other EU countries do.

In EU, the total level of investment – in products, processes, people and strategy, is at 11.42%, relatively close to the 11.5% of total sales achieved in 2005. The story is the same in Denmark; a fall from 19.9% to the EU average of 11.5% was experienced between 2001 and 2005, but it seems the level has been stable since. Interestingly, the Eastern European countries that have experienced insourcing of production from e.g. Danish companies have the lowest level of total investments of all countries, with Romania in the bottom, investing only 9.47% of sales. In the other end, India and China are among the top spenders.

Could it be that Danish companies feel that their production systems are up-to-date? That their workforce has reached an optimal level of training and education, and that young employees are better prepared by the regular educational system than they are in other countries? Or do we actually measure complacency, leading Danish and other EU companies to underestimate the effects the complexity and speed of change of the market place will have on their flexibility and innovativeness? The fact that Indian companies invest much more in training & education *and* achieve much better improvement results in a range of performance areas and especially regarding innovation related performance indicators (Table 13) suggests there is reason for concern!

9.3 Performance Improvements Achieved 2010-2012

Manufacturing companies in Denmark, as well as in the rest of Europe, have to continuously adapt to new performance requirements in terms of cost, quality, flexibility, speed, and innovativeness. The companies were asked to indicate how their performance had changed on 18 indicators (Table 8) over the past three years.

Relative to their European counterparts, companies outside the EU score slightly higher on most indicators but the differences are generally small.

In terms of improvements achieved, Denmark is very close to, or on the EU-averages, except for some points; *Delivery reliability* and *unit cost,* where Danish companies have achieved a score of .3 higher than the other European companies. On the other hand, Danish companies only achieved an improvement of 2.4 in *pollution & waste,* a performance indicator that is usually regarded very important to Danish companies.

Overall, Danish companies report the highest improvements in the areas of quality and flexibility.

Table 13 - Manufacturing performance: Improvements achieved last three years
(1 = deteriorated more than 5%, 5 = improved more than 25%)

Performance improvements pursued the last 3 years																		
Performance objective	Quality			Flexibility		Innovation		Customer service		Cost		Speed				CSR and environment		
Performance indicator / Country	Customer quality	Product quality	Delivery reliability	Volume flexibility	Mix flexibility	Product customization ability	Introduction ability	Product assistance	Customer service quality	Unit cost	Ordering costs	Delivery speed	Manufacturing lead time	Procurement lead time	Resource consumption	Pollution and waste	Workers' motivation	Health and safety
Belgium	3.2	3.2	3.0	3.4	3.1	2.7	3.2	2.6	3.1	2.3	2.2	2.9	2.9	2.5	2.6	3.0	2.6	3.4
Canada	3.4	3.5	3.3	3.2	2.8	3.0	3.0	2.9	2.9	2.9	2.5	3.0	3.0	2.7	2.6	2.3	2.7	3.3
China	3.5	3.5	3.6	3.3	3.3	3.5	3.5	3.4	3.3	2.6	2.5	3.6	2.8	2.7	2.6	3.0	3.3	3.6
Denmark	2.9	3.0	3.5	3.3	3.2	2.9	3.1	2.7	2.7	2.9	2.3	3.1	3.1	2.4	2.4	2.4	2.8	3.0
Finland	2.6	2.9	2.9	3.5	3.1	2.8	3.0	2.3	2.4	2.4	2.3	3.2	2.9	2.8	2.3	2.8	2.7	3.1
Germany	3.0	2.7	3.1	3.4	3.0	3.1	3.3	2.8	2.6	2.5	2.3	3.0	3.0	2.5	2.5	2.6	2.8	2.7
Hungary	3.0	3.2	3.0	3.4	3.0	2.9	3.2	2.8	2.6	2.5	2.4	2.9	2.9	2.8	2.7	2.8	2.5	2.8
India	3.5	3.5	3.5	3.3	3.1	3.4	3.5	3.3	3.3	2.3	2.4	3.4	2.7	2.7	2.7	2.9	3.3	3.5
Italy	3.1	3.2	2.9	3.2	3.6	3.1	3.1	2.9	2.8	2.7	2.3	3.1	3.2	2.9	2.6	2.9	2.5	3.6
Malaysia	3.2	3.6	3.4	3.5	3.1	3.2	3.3	3.1	3.0	2.5	2.6	3.5	2.6	2.6	1.9	2.5	3.0	2.9
Netherlands	2.8	3.0	3.1	3.0	2.9	2.7	3.0	2.6	2.6	2.6	2.3	2.9	2.7	2.6	2.4	2.4	2.6	2.7
Norway	3.4	3.6	3.2	3.6	3.4	3.3	3.0	3.5	3.1	3.0	3.0	3.1	3.2	2.9	3.1	3.4	3.3	3.5
Portugal	3.6	3.5	3.6	3.5	3.3	3.4	3.7	2.9	2.8	2.7	2.5	3.6	3.2	2.5	2.6	3.3	2.9	3.6
Romania	3.1	3.7	3.8	3.7	3.6	3.3	3.8	3.3	3.5	2.6	2.5	3.8	3.0	3.0	2.7	3.6	3.1	3.6
Slovenia	3.2	3.4	3.6	3.6	3.8	3.5	3.6	3.2	3.2	2.9	2.9	3.6	3.1	2.9	2.7	2.8	3.2	3.6
Spain	2.8	3.3	3.1	3.1	3.1	3.2	3.5	3.0	3.0	1.9	2.2	3.2	2.2	2.4	2.2	2.1	2.6	3.3
Sweden	3.4	3.5	3.4	3.4	3.4	2.9	3.0	2.8	2.7	2.8	2.5	3.3	3.0	2.5	3.0	2.9	3.0	3.4
Switzerland	2.8	2.6	2.6	2.9	2.8	2.6	2.9	2.3	2.5	2.4	2.8	2.6	2.8	2.5	2.5	2.6	2.5	3.0
Taiwan	2.8	3.2	3.2	3.0	3.0	3.0	3.1	3.0	3.2	2.8	2.8	3.1	2.8	2.9	2.9	3.0	3.2	3.0
EU	3.1	3.2	3.2	3.4	3.2	3.0	3.2	2.8	2.8	2.6	2.4	3.2	2.9	2.7	2.6	2.8	2.8	3.2
Non-EU	3.4	3.5	3.5	3.3	3.1	3.4	3.4	3.3	3.3	2.5	2.5	3.4	2.8	2.7	2.6	2.9	3.2	3.5
Total	3.2	3.3	3.3	3.3	3.2	3.2	3.3	3.0	3.0	2.6	2.5	3.3	2.9	2.7	2.6	2.9	3.0	3.3

In the larger picture, it is seen that economies from Eastern Europe, with Romania and Slovenia in front, generally had the best performance improvements. Emerging economies like China and India are also doing okay, while Norway, a country whose industrial sector is usually compared to the Danish, surprisingly is among the top three countries.

10 Current Manufacturing and Integration Activities

Manufacturing strategy can be understood as "what companies intend(ed) to be and do" but also

as “what companies are and do”. A successful manufacturing strategy results in a configuration of processes, technologies, systems, competences, practices and form of organization, embedded in a well-designed supply chain, which supports the strategic intent of the company. This section deals with the current manufacturing practices in two different aspects: “Manufacturing process type and planning & control systems” and “New product development-manufacturing integration”.

10.1 Manufacturing Process Type and Planning & Control Systems

A comparison between the Danish and other IMSS companies’ manufacturing process and planning and control systems summarized in Table 9 reveals various similarities and differences.

The following will be based on the fabrication phase.

Danish and other EU companies differ little in the way they organize manufacturing. About 60% of Danish production is produced as *batch production process*. This is 8 percentage points more than the European average. The percentage of production as *one-off production* is slightly below the EU-average, while *mass production* is 6 percentage points below that average. This goes along fine with the common believe that Denmark is not a mass-producing country. The only country with less mass production than Denmark is Finland. Finland also has the highest level of one-off production in the sample.

India and China have just as high a share of mass production as expected, more than 30%, and especially India is producing much more to stock than other companies (more than double of the percentage EU countries are producing to stock.) Interestingly, Norway and Belgium comes in on a 3rd and 4th place when it comes to mass production, even though Norway has the second highest amount of design to order, meaning that the order penetration point is further up the ladder than many other EU countries.

In Denmark, industry has put considerable efforts into becoming more flexible, introducing pull production wherever possible, and this is reflected in the figures. Relative to 2001 *production to stock* has fallen drastically, from 38% to 19.9%, and similar improvements has been seen in the other fields, meaning that Denmark is in front of both EU- and Non-EU averages, when it comes to products that are designed to order.

Overall, the data suggests a combination of focus and “polarization”. Production (manufacturing, assembly) to order has come to dominate Danish industry, and pull and a mix of push-pull should be the dominant planning principles. At the same time, batch production is by far still the dominant process choice.

Table 14 - Key process characteristics (in % of all companies from each country)

Key process characteristics										
Phase	In the fabrication phase			In the assembly phase			Order entry point			
Process aspect / Country	One of a kind	Batch production	Mass production	One of a kind	Batch production	Mass production	Design to order	Manufacture to order	Assemble to order	Produce to stock
Belgium	13.2	55.8	31.0	27.0	43.6	29.4	9.7	36.2	38.1	16.0
Canada	39.7	51.8	8.5	50.1	39.5	10.4	9.6	41.9	32.1	16.4
China	21.0	43.8	35.2	24.5	46.6	29.0	18.5	49.3	15.7	16.6
Denmark	30.4	60.7	8.9	40.5	51.0	8.5	19.3	28.4	32.3	19.9
Finland	42.4	50.3	7.3	58.8	35.2	5.9	22.8	46.4	21.2	9.5
Germany	17.2	68.9	13.9	28.7	65.2	6.1	12.5	54.1	22.8	10.7
Hungary	34.3	46.6	19.1	37.3	46.5	16.2	14.4	57.9	17.1	10.7
India	30.5	32.8	36.7	35.0	26.7	38.3	17.2	25.0	29.3	28.4
Italy	40.7	50.5	8.8	51.6	38.3	10.1	20.8	37.1	29.7	12.4
Malaysia	24.3	49.6	26.1	24.3	51.3	24.3	22.0	38.0	30.0	10.0
Netherlands	32.0	59.4	8.6	42.8	52.0	5.2	17.2	24.9	39.7	18.2
Norway	40.7	27.9	31.4	55.3	28.3	16.4	25.4	25.1	33.2	16.3
Portugal	33.3	53.5	13.2	39.3	45.8	14.9	19.5	51.8	21.1	7.6
Romania	34.1	45.3	20.7	36.9	45.8	17.3	20.5	52.1	17.2	10.2
Slovenia	31.1	54.8	14.1	34.6	55.1	10.3	26.2	40.5	25.3	7.9
Spain	29.2	61.4	9.3	32.4	60.7	6.9	10.9	56.9	13.2	18.9
Sweden	26.7	62.3	11.0	40.0	52.2	7.8	13.0	30.4	38.2	18.4
Switzerland	32.4	49.9	17.7	39.9	44.8	15.4	10.4	40.6	33.2	15.8
Taiwan	8.1	72.9	19.0	9.4	77.8	12.8	23.3	53.7	16.3	6.8
EU	32.3	52.7	15.0	41.4	46.5	12.2	17.3	41.3	27.4	13.9
Non-EU	25.6	42.5	31.9	30.2	39.4	30.3	17.8	38.3	23.4	20.5
Total	29.7	48.7	21.6	37.0	43.7	19.3	17.5	40.2	25.8	16.5

10.2 NPD-Manufacturing Integration

To fulfill manufacturing and product development objectives, a wide range of allocation and co-ordination decisions have to be made. Recently integrating other parts of the organization in the development in new products have won new grounds. Denmark is generally a bit behind the rest of Europe, which again is behind the rest of the world, when it comes to NPD integration. Only in integration of design into NPD, is Denmark marginally in front of the rest of the EU. Informal communication is another field helping the integration of NPD into the rest of the organization. In this point, Denmark usually scores pretty high as the distance between organizational levels as well as the distance between departments is usually very low in Denmark. However it looks like recent development means that Denmark is putting very little effort into keeping informal mechanisms in the organization, meaning that Denmark have been overtaken by almost every

other country. Even China and India (India is best performing in this field), where there is usually a larger organizational distance, has better implementation of informal mechanisms.

Table 15 – Degree of use of NPD-production integration mechanisms
(1 = no use, 5 = high use)

Degree of use of NPD-production integration mechanisms							
NPD integration mechanism / Country	Informal mechanisms	Design integration	Organizational integration	Technological integration	Integrating tools and techniques	Communication technologies	Process standardization
Belgium	3.2	2.8	2.9	2.8	2.7	3.1	3.1
Canada	2.8	2.9	2.7	2.4	2.2	3.0	2.5
China	3.5	3.4	3.4	3.4	3.2	3.6	3.5
Denmark	3.3	3.2	3.0	2.7	2.5	3.3	3.3
Finland	3.1	2.9	2.8	2.5	2.2	2.9	2.8
Germany	3.3	2.9	3.1	3.5	3.5	3.4	3.2
Hungary	3.6	3.3	3.1	2.9	3.0	3.4	2.9
India	4.1	3.9	3.9	4.0	3.9	4.0	4.0
Italy	3.4	3.0	2.8	3.1	2.7	3.1	2.9
Malaysia	3.4	3.6	3.1	3.5	3.2	3.5	3.4
Netherlands	3.0	2.9	2.7	2.5	2.5	2.9	2.7
Norway	3.7	3.4	3.7	3.3	3.0	2.9	2.8
Portugal	3.6	3.2	3.3	3.0	3.2	3.6	3.2
Romania	3.8	3.5	3.4	3.1	3.1	3.1	3.2
Slovenia	3.7	3.8	3.4	3.4	3.4	3.9	3.5
Spain	3.7	3.0	3.5	2.7	3.2	3.5	3.4
Sweden	3.2	2.8	3.1	2.7	3.2	3.5	3.5
Switzerland	3.2	3.0	2.9	2.9	2.9	2.9	2.8
Taiwan	3.9	3.9	4.0	3.9	4.0	4.0	4.0
EU	3.4	3.1	3.1	2.9	2.9	3.2	3.1
Non-EU	3.7	3.6	3.6	3.6	3.5	3.7	3.6
Total	3.5	3.3	3.3	3.2	3.1	3.4	3.3

Generally the companies in the East are the companies with most focus on implementing NPD-integration mechanisms. India is currently the country with the most focus, followed by Taiwan, which is only .1 points behind India. The worst performers in NPD are Canada and Finland, but Denmark is not doing much better, ending as the country with the 7th worst degree of NPD-integration. This fits very well with the effort put into implementation of NPD-programs, as can be seen in table 7.

Overall, the data suggest that Danish companies might want to pay more attention to improving the NPD-production interface before being overtaken by the well performing Eastern European countries or the companies in the far East. Europe and, thus, also Denmark are lacking well behind the rest of the world on the use of some important mechanisms, such as process standardization, ICT and technological integration.

11 Organization and People Management

A well-trained and motivated workforce working under supportive organizational conditions is important for the prosperity of any company and country. This section outlines how the participating companies maximize the ability of their employees to run and continuously improving the business they are in.

With 27 hours of *training* per employee per year, Danish industry is only surpassed by Portugal, Belgium and Taiwan. This looks like the picture from 2005, where Danish companies were only surpassed by Portugal and China. This also means that Danish companies have the highest *percentage of multi-skilled workers*. A many as 64,9% of the workers are considered multi-skilled. Only other highly educated, high-wage countries have a percentage close to this, and countries with relatively low wages are very much behind on this factor, leaving China in the bottom with only 28.1%. This also means that Danish companies have one of the highest degrees of implementation of *delegation and knowledge*.

Having such a well-educated workforce also means that they are in many ways more flexible, and when it comes to *worker flexibility,* Danish companies are among the best, well in front of both EU and non-EU averages.

In Denmark, we have a tradition of openness and visibility, and even in large companies, it is often accepted for the average worker on the floor to talk to the top layer of management if problems arise. This is also reflected in the table. Apart from the fact that Danish companies are the least bureaucratic when it comes to the *number of organizational levels*, Danish companies are also among the companies with the highest implementation of *Open communication.*

Northern European companies are generally known for their high emphasis on teamwork, and this is also reflected in the data, to some extent. Danish companies have a much larger degree of workers' compensation coming from work group incentives, than from individual incentives, and also a larger degree than the EU and non-EU averages. However, most Danish workers are still paid a fixed salary, compared to for instance Taiwan, where, according to the table, almost 80% of the workers compensation derives from individual and work group incentives. Also in Germany, the sum of compensation, coming from individual and work group incentives, are much larger than the Danish sum. Some of this could be explained by the Danish model and very strict Danish labor agreements.

Table 16 – Organization and people management[9]

Organization and people management													
	Organization				Incentives (In % of workers' compensation)		Training & knowledge			Teamwork	Flexibility		Communication
Country	Number of employees	Number of organizational levels	Workers / Line supervisor	Lean organization (Implementation 1-5)	Individual incentives	Work group incentives	Number of training hours / employee / year	Percentage of workers multi-skilled	Delegation & knowledge (Implementation 1-5)	Autonomous teams (Implementation 1-5)	Worker flexibility (Implementation 1-5)	Flexible forms of work (Implementation 1-5)	Open communication (Implementation 1-5)
Belgium	5606	4.3	62.10	3.0	1.3	12.9	34	57.4	2.7	2.5	3.4	3.0	3.2
Canada	3925	3.4	25.90	3.3	1.3	4.1	21	63.3	2.9	2.7	3.6	2.3	3.8
China	4706	-	59.36	3.4	26.1	11.6	-	28.1	3.1	3.0	3.0	2.6	3.2
Denmark	1337	3.4	46.59	3.5	14.9	21.2	27	64.9	3.4	2.8	3.5	3.0	3.8
Finland	743	3.6	30.98	3.0	13.2	16.3	21	52.4	3.0	2.9	3.5	3.4	3.4
Germany	15156	3.6	17.88	3.1	40.9	32.1	21	61.5	2.8	2.8	2.9	2.7	3.3
Hungary	802	3.9	17.61	3.0	8.9	5.6	19	39.2	3.1	2.8	3.1	2.9	3.6
India	718	-	43.50	3.8	21.4	18.8	-	34.9	3.7	3.5	3.4	3.5	3.7
Italy	1827	4.2	23.58	3.2	7.8	10.4	-	37.4	2.9	2.8	3.1	3.0	3.3
Malaysia	2964	-	44.40	3.6	23.2	39.1	-	51.5	3.3	3.4	3.6	2.8	3.6
Netherlands	1744	-	25.01	3.0	11.1	14.3	-	59.0	3.0	2.7	3.4	3.0	3.5
Norway	350	3.5	13.71	3.6	29.8	35.0	26	46.8	3.3	3.4	3.6	3.0	4.0
Portugal	6163	4.2	28.36	3.5	14.5	16.3	35	54.7	3.6	3.2	3.6	3.1	3.9
Romania	146	4.1	20.32	3.3	14.6	13.3	24	43.0	3.1	2.9	3.4	2.6	3.6
Slovenia	257	3.9	22.03	3.4	33.8	34.6	28	52.6	3.5	3.3	3.6	3.4	3.8
Spain	1358	3.6	17.11	3.4	8.9	2.0	24	58.5	3.1	2.8	3.7	2.9	3.6
Sweden	6287	4.1	36.22	3.6	6.9	2.4	26	55.2	3.5	3.1	3.6	3.1	3.7
Switzerland	914	-	21.83	3.1	5.5	2.1	19	47.4	2.9	2.3	3.2	2.7	3.4
Taiwan	7721	6.0	154.62	3.7	38.6	48.4	39	36.8	3.4	3.2	3.5	3.3	3.5
EU	2657	-	27.23	3.2	13.0	13.7	36	51.0	3.1	2.9	3.4	3.0	3.6
Non-EU	3187	-	57.24	3.6	22.7	17.6	95	35.4	3.4	3.2	3.3	3.0	3.5
Total	2868	-	39.00	3.4	16.8	15.2	60	44.9	3.2	3.0	3.4	3.0	3.5

[9] While some countries had very large inconsistencies in the data to some questions, it was decided to exclude these countries from the analysis.

12 IMSS and Best Practices

With the data from IMSS VII, which is also the fundament of this report, an analysis of current best practices has also been made. According to Hansen (2014), the following table has been constructed, showing the current practices that emerged from the analysis as best practices:

Table 17 - Best practices in 2013 and their implementation

Best practices in 2013	Implementation DK	Implementation average
Pull production	3.1	3.2
Factory of the future	2.1	2.6
Joint sustainability efforts with suppliers	1.9	2.7
Expanding the service offering	2.7	3.0

The results of this analysis came by applying linear regression to 26 of the practices / action programs evaluated in the IMSS VII. Data from all countries were used. The practices with a positive, significant beta value of $\beta > 0.1$ in all performance parameters were regarded best practices. Since these practices show a significant positive effect on all performance parameters, they should receive extra attention in the next period.

13 Discussion and Conclusions

13.1 Validity

Before discussing the results of this analysis, a quick discussion of the validity of the data-material is in place. As for most of the questions in IMSS VI, the data material for this report was based on five-point Likert scales, usually ranging from 1 = much lower to 5 = much higher (for performance compared to three years ago and relative to competitors) or 1 = none to 5 = high (for implementation efforts in action programs in the last three years and current level of implementation). Thus, the answers are not completely objective; they reflect the respondent's perceptions and may be culturally biased. As an example of this, it is hard to believe that Taiwanese and Indian companies "focus" on everything, as it is otherwise presented in the data-material. Though these countries generally have a less developed infrastructure, meaning that they also have much better room for improvement, a country as China is supposed to be at about the same level of development, but Chinese companies' answers are closer to those of Eastern Europe than to Indian and Taiwanese company answers. Again, multiple explanations could explain and influence this, but cultural variance cannot be rejected.

13.2 The Strengths of Danish Companies

Danish companies are doing pretty well in this analysis. Sales revenue is increasing, as is the ability to earn money on sales. However, according to this analysis, Danish companies do not have any fields at all, where they perform better than their counterparts in the rest of Europe or the rest of the world. However, since this report is mostly generated from looking at the development over the last three years. It is possible that Danish companies are still in front, even though Eastern European companies and companies from especially India, must be catching up, since they are

reporting much better performance development rates than Danish companies are.

13.3 Some Concerns

There are also some reasons for concern, especially as regards the implementation of action programs. Danish companies generally have the lowest rate of effort put into pursuing action programs. In both supply chain management and risk management, Denmark has put the least effort of all the countries participating in the survey. In Production processes action programs, Denmark put only the second least, while Canada placed the last in the world. In the development of service skills and implementation of environmental and CSR programs Denmark is also among the countries with the absolute lowest degree of effort put into implementation.

As seen in chapter 12, some general trends can be seen when looking at the connection between degree of implementation of action degree and performance. Some action programs generally leads to significant performance improvement in all fields. Just like the general image showing that Danish participants in IMSS is lagging behind on practice implementation, it also becomes obvious while looking at table that Denmark is also way behind other countries when it comes to the current best practices.

If this trend is not broken, other players, either from other European countries or from the global market, will sooner or later overtake Danish companies.

13.4 Conclusion

Danish companies are successful in many ways. Looking at the development over the last three years, however, the effort put into pursuing action programs is worrying. Nonetheless, Danish companies are still making good money and report a better-than-average general economic development.

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